S101 AV 16, 17

Course Notes

The OPEN UNIVERSITY

Science: A Foundation Course

Instructions for Making Molecular Models

1 Models of maleic and fumaric acids

The molecular model kit contains two main types of component: small plastic pieces with arms to represent atom centres, and green straws to represent bonds (Figure 1).

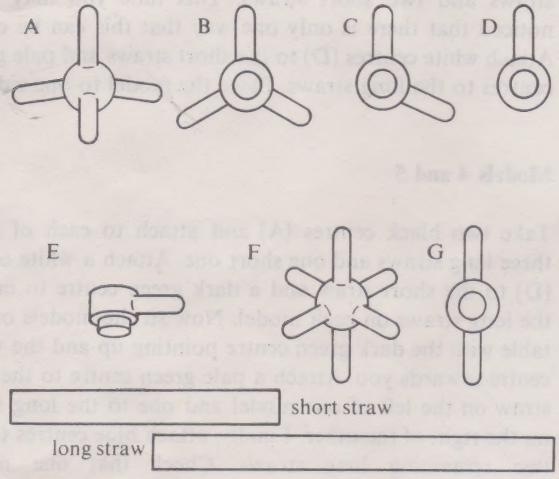

FIGURE 1 The atomic centres and straws in the model kit.

Type		
A	black	saturated carbon atoms
B	black	carbon atoms involved in double bonds
C	red	saturated oxygen atoms
D	red	oxygen atoms involved in double bonds
D	white	hydrogen atoms
E	white	pegs for double bonds
F	grey	centres for the audio-vision sequence part I
G	black	carbon atoms involved in triple bonds

Type G are not required for any of the model exercises, but are included in case you wish to make models of alkynes.

The straws simply push onto the arms. To make these models you need the following components:

8	carbon atoms	(type B—black)
4	oxygen atoms	(type C—red)
4	oxygen atoms	(type D—red)
8	hydrogen atoms	(type D—white)
12	pegs	(type E—white)
18	long straws	
8	short straws	

Construct the models in parallel. Make two carbon–carbon double bonds as follows. Each one is made by joining two type B centres with a long straw, joining two pegs with a long straw, and pressing the Bs and Es together as in Figure 2a. Attach one long and one short straw to each carbon atom: for one double bond, the long straws should be attached on the same side (Figure 2b); in the other double bond they should be attached on opposite sides (Figure 2c).

Make up four carboxyl groups as follows. For each, make a carbon–oxygen double bond by joining a type B centre and a type D (red) centre with a long straw; join two pegs (type E) with a long straw; press the B–D system and the joined Es together.

Join a type C centre to a type D (white) centre with a short straw. Join this (the OH group) to the previously constructed C=O group with a long straw between the type B centre and the type C centre (Figure 3). Finally, join these carboxyl groups to the carbon–carbon double bonds using the long straws already attached, and insert two type D (white) centres into the two short straws. Your finished models should look like the ones in Filmstrip 2, Frames 8 and 9.

Use your two models as you read the main text up to the end of Section 3.2.

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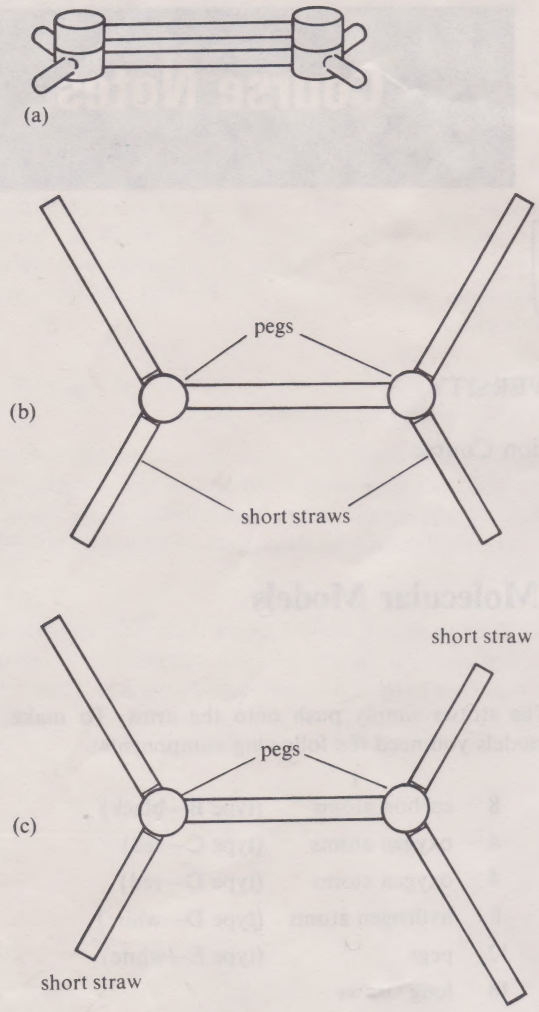

FIGURE 2 The two carbon–carbon double bonds you should have made.

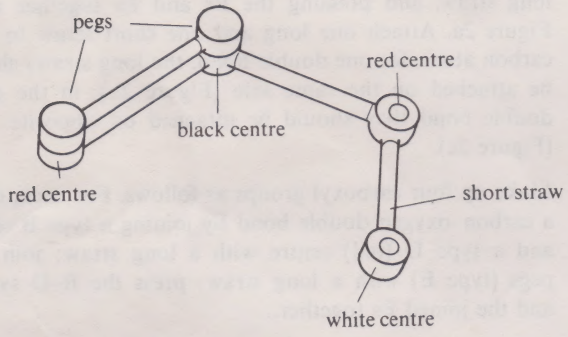

FIGURE 3 The carboxyl group you should have made.

2 Audio-vision sequence part I

Part I of the audio-vision sequence for Units 16 and 17 is associated with Section 4.1 of the main text. It is used to show you, with the aid of models, the existence of a third type of isomerism. You will need the following: a table on which to work; a mirror, preferably at least 12 cm × 12 cm in size, standing vertically facing you with a working area in front; the stereoviewer with Filmstrip 5 positioned at Frame 26; and Filmstrip 6. In addition you need to construct the molecular models described below. You will need the following components from the model kit (see Figure 1):

7 carbon atoms (type A—black)
10 hydrogen atoms (type D—white)
16 fluorine atoms (type D—pale green)
2 chlorine atoms (type D—dark green)
2 bromine atoms (type D—blue)
2 centres (type F—grey)
22 long straws
12 short straws

Models 1 and 2

Take the two grey centres (F) and attach to each two long straws and two short straws so that they all lie in a plane (that is, so that the model is essentially flat). You may have noticed that you can do this in two ways: you can have the long straws adjacent to each other or they can be opposite each other. If you have not already got one of each type, alter one of the models appropriately. Now attach white centres to the short straws and pale green centres to the long straws. Place the models to one side.

Model 3

Take one of the black centres (A) and attach two long straws and two short straws. This time you may have noticed that there is only one way that this can be done. Attach white centres (D) to the short straws and pale green centres to the long straws. Place the model to one side.

Models 4 and 5

Take two black centres (A) and attach to each of them three long straws and one short one. Attach a white centre (D) to the short straw and a dark green centre to one of the long straws on each model. Now sit the models on the table with the dark green centre pointing up and the white centre towards you. Attach a pale green centre to the long straw on the left of one model and one to the long straw on the right of the other. Finally, attach blue centres to the two remaining long straws. Check that one model corresponds *exactly* to the model in front of the mirror in Filmstrip 5, Frame 28 and the other corresponds *exactly* to the model at the side of the mirror. (You will have to rotate the models.) Place the models to one side.

Models 6 and 7

Join two black centres (A) with a long straw. Attach two long straws and one short straw to each black centre. Now make up another model in exactly the same way. Attach white centres (D) to each of the short straws and light green centres to the long straws. Place the models to one side.

Now listen to Side 2, Band 5 of the second S101 cassette tape (AC 91), stopping the player when instructed to do so or if you need time to think or manipulate the models. Then return to ITQ 4 in the main text, p. 40.

3 Audio-vision sequence part II

Part II of the audio-vision sequence for Units 16 and 17 is associated with Section 6.3 of the main text. It is used to show you with the aid of models the importance of shape in polymer molecules. You will need the following: a table on which to work; the stereoviewer with Filmstrip 7 positioned at Frame 33; and Filmstrip 8. In addition you need to construct a model representing part of a polypropylene molecule. You will need the following components from the model kit (see Figure 1):

15 carbon atoms (type A—black)
30 hydrogen atoms (type D—white)
15 long straws
30 short straws

1 Attach one white centre (D) to each of the 30 short straws.

2 Take five black centres (A) and to each of them attach one long straw and three short straws. This will give you five methyl groups ($-CH_3$).

3 Take five more black centres (A) and to each of these attach one short straw, two long straws and one methyl group (from 2) to give five $-CH(CH_3)-$ groups.

4 Take the remaining five black centres (A) and attach to each two short straws to give five $-CH_2-$ groups.

5 Now join each $-CH_2-$ group to a $-CH(CH_3)-$ group (from 3) to give five $-CH_2-CH(CH_3)-$ groups. These are the building blocks of polypropylene derived from propylene (propene) $CH_2=CH-CH_3$ by opening the double bond.

6 Now join these five $-CH_2-CH(CH_3)-$ groups together to form a polypropylene chain.

In making this model you have in a sense simulated the polymerization of propylene. In reality, the polypropylene would contain several hundred monomer units. None the less, this small section is adequate to demonstrate a number of points.

Now listen to Side 1, Band 1 of the third S101 cassette tape (AC 92), stopping the player when instructed to do so or if you need time to think or manipulate the models. Then return to the end of Section 6.3 of the main text, p. 65.

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